Lab 05: Graphing With Spreadsheets
When You Need to Display Your Data

INTRODUCTION

If you already have some experience working with spreadsheets, you may be aware that it makes very little difference what platform you use. For example, MS Excel, Google Sheets, OpenOffice Calc all look and operate virtually identically. While some of the details may differ in terms of menus or toolbars, the sheets themselves all operate using the same fundamental rules.

While a spreadsheet may not always be your go-to tool for complex data analysis, it is absolutely necessary to have basic spreadsheet skills in your engineering toolkit. A spreadsheet is capable of very sophisticated calculation and analysis, but we can't learn everything all at once. We will focus on some basic data handling, learning some shortcuts, and presenting graphs.

OBJECTIVES

The specific goals for this exercise are:

- Choose a spreadsheet platform
- Design a simple spreadsheet for grade tracking
- Use built-in formulae to perform routine calculations
- Build a spreadsheet to analyze physical data
- Present data in a graphical format

PRE-LAB PROCEDURE

1. View the platform. We'll be using Google Sheets. If you have no experience using a spreadsheet, Sheets has a pretty shallow learning curve. If you've used MS Excel, or some other spreadsheet package, Sheets will be an easy transition. Fire up a browser window and log into Google using your UCA account. Click the Apps icon and select Sheets to open a blank spreadsheet. Spend a few minutes pulling down the menus and clicking around the toolbar to get familiar with the interface.

2. Download the documents. The supplementary documents for this lab are located on the ENGR1301 course web, or in the ENGR 1301 course folder.

3. Examine the contents. Open the grades.csv file using a text editor (*not* a word processor, and not a spreadsheet program either). A .csv (comma-separated values) file is a plain-text file that a spreadsheet will display in tabular form. A .csv file won't preserve the formatting or the formulas of an .xlsx spreadsheet file. Notice that there are several formulae written as text. You will use the same syntax when you edit formulae in the spreadsheet program.
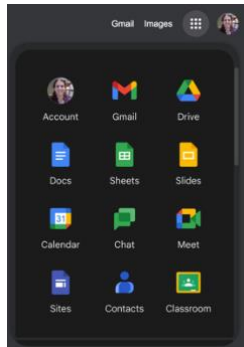
PRACTICE YOUR FORMATTING

4. Open the .csv file. Open the grades.csv file using Sheets. Notice that the columns line up, but that it is not formatted like the example sheet.

5. Convert to spreadsheet. Google sheets will automatically save as a spreadsheet. Click the header next to the icon at the top left to rename your sheet using the filename lastnameLab05.xlsx. Once the sheet is named, you can click the folder icon next to it to put it in the folder of your choosing on your Google drive. (However, in Excel you must save the grades.csv as an .xlsx file!) This will preserve the formatting and formula changes you will now make to the original sheet. *Do not save as a .csv!*

6. Copy the pattern. Before you worry about making the sheet look pretty, get it functioning properly. You should be able to recognize the pattern for the SUM formula and use it to replace the numeric totals with the correct formula using the correct range of cells.

7. Test the programming. If you have correctly entered in the formulae, you should be able to complete the grade sheet with numeric values, and it should properly keep a running tally of your grade. You can easily test by giving yourself perfect scores on everything; if you have any programming errors, you should be able to see them in your sub-totals. If you want to make your sheet automatically calculate your letter grade, you can use the following conditional statement:

=IF(H32>=0.895,"A",(IF(H32>=0.795,"B",(IF(H32>=0.695,"C",(IF(H32>=0.595,"D","F")))))))

in which H32 is the cell containing the numeric average.

8. Format and save. You do not have to match the format of the sample sheet precisely, but take a few minutes to play around with making the sheet look neat and professional. Make sure you are saving as a spreadsheet! *Double check* that you are *not* saving as .csv, which will not save your formatting. Save as a spreadsheet!!!!

PRACTICE YOUR PROGRAMMING

9. Open a new tab. Open a fresh sheet (new tab) in the same workbook (not a new file!). You will be using this blank new sheet to calculate and plot the downward velocity of a falling object subject to air resistance.

	A	B	C
1	Free-Fall: Gravity Opposed By Air Resistance		
2	Initial Parameters To Be Set By User		
3	delta_t =		time interval
4	g =		acceleration due to gravity
5	m =		mass of object
6	b =		drag coefficient
7	v_i =		initial velocity (down = +)
8	Calculated Velocity and Displacement		
9	Time (s)	Velocity (m/s)	Distance (m)
10	0	=v_i	0
11	=a10+delta_t		

10. Rows and columns. Begin by using my example above to organize how you will enter your information. Always remember to save often!

11. Name your ranges. Rows 3–7 above are establishing the initial parameters of the problem. In Sheets, click on the cell address box above the column headers and label the cell B3 as delta_t. Or use the pulldown menu Data→Named ranges. Repeat for the remaining initial parameters. By using named ranges, we can change these
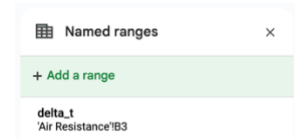
parameters quickly, and understand easily what we are altering. We can even do the calculation for Mars by changing the value of g.

12. **Increment the time.** Notice the formula: simply add delta_t to the previous value. Copy and paste the formula down the column. Paste down at least 200 rows (500 is better). *Save!*

13. **Calculate the velocity.** Assume that, since the acceleration due to gravity points down, down is the positive direction. This means that if your object was initially thrown *up*, it would have a *negative* initial velocity v_i (v_i). The velocity as a function of time is then calculated using:

$$v_2 = v_1 + \left(g - \frac{b}{m}v_1^2\right)\Delta t$$

which translates into the spreadsheet syntax as =B10+(g-(SIGN(B10))*(b/m)*(B10)^2)*delta_t when typed into cell B11. You should be able to copy and paste the formula down the velocity column through the end of your time interval. Save!

14. **Determine the distance.** Again, if we assume down as the positive direction (and we release the object from $y_i = 0$), then the drop from the initial position will be positive as well. Displacement is calculated using:

$$y_2 = y_1 + \left(\frac{v_1 + v_2}{2}\right)\Delta t$$

which translates into the spreadsheet syntax as =C10+((B10+B11)/2)*delta_t when typed into cell C11. You should be able to copy and paste the formula down the distance column through the end of your time interval. Save!

15. **Make a graph.** Highlight your time and velocity columns. Click the Chart icon in the toolbar, then the Scatter chart option. This will generate a plot of velocity (y) as a function of time (x). Notice the Chart Editor pops up, and that lets you customize almost every aspect of your graph. Label your axes (typically clicking on the thing you want to change is also an effective strategy if you aren't sure what to do). *Save!*

16. **Make another graph.** Now highlight the distance column, and click the Chart icon, then Scatter chart. Notice that you get a plot of distance (y) as a function of nothing (x is just a count). Make the x–axis mean something! Click Add X-axis. The range for the x–axis must be changed to match the time column.

17. **Make it professional.** Spend a few minutes looking at the format of your sheet. You are not required to make it identical to the example I have provided, but please make your sheet look neat, well-organized, and professional.

18. **Save and submit.** Please submit your saved workbook (containing both spreadsheets) through the Blackboard Assignment. Please be sure to use the filenames lastnameLab05 for your workbook. Please also make sure that you have saved or exported to the .xlsx (MS Excel) file format. *Do not save your sheets as* .csv! This does not preserve the formulae or the formatting.
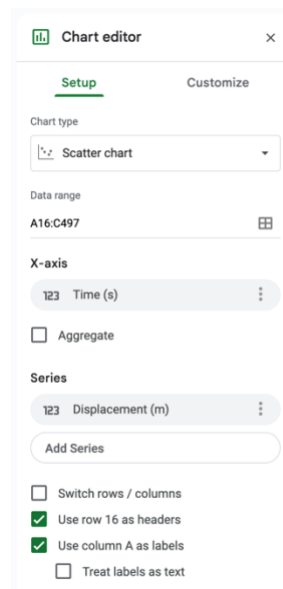
SAVE AND SUBMIT

Submit your spreadsheet workbook electronically via Blackboard no later than 6:00 PM on Tuesday, 27 February 2024. You must submit using the Blackboard Assignment.

You will receive full credit (8 points) for completing the gradebook spreadsheet. The submitted sheet must function correctly in all places, but you will not be scored for the format of your sheet.

The air resistance spreadsheet will be worth 22 points. The submitted sheet will be evaluated for both content and presentation. To receive full credit, you must have a properly programmed sheet that functions correctly when the initial parameters are varied. You must also format your sheet so that it presents as neat, well-organized, and professional.

GRADING RUBRIC

The following rubric will be used to evaluate your spreadsheets:

ASSESSMENT	CRITERIA / VALUE		POINTS EARNED
Spreadsheet Workbook DUE: Tue 27 Feb 24 (filename: lastnameLab05)	Sheet has been programmed correctly	8 points	
	Correctly establishes and uses named ranges	4 points	
	Correctly calculates time, velocity, and displacement	4 points	
	Velocity vs time graph: Correct ranges, correctly labeled	4 points	
	Displacement vs time graph: Correct ranges, correctly labeled	4 points	
	Data format: Sheet appears neat, well-organized, and professional	3 points	
	Graph format: Graphs are well formatted and easy to interpret	3 points	